

# **Shark Screw Air Compressor**

## **Installation, maintenance and user manual**

$0.7 \sim 55 \text{m}^3 / \text{min}$   $0.7 \sim 1.25 \text{Mpa}$

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## **Preface**

**Welcome to select shark screw air compressor.** All our products have been checked and tested before leaving factory. In order to make sure the air compressor can be used safely, reliably and durably, please read this manual carefully before installation and test run of it. Only people who are familiar with the structure and function of the set can operate and maintain it.

1. If not pointed out, all the pressure in this manual means gage pressure (relative pressure)
2. When user connects with our company for the problems of maintenance, service and other things about the air compressor, please point out the machine type and the exhaust pressure which are marked on the name plate of machine and warranty card.
3. Please use the special lubricant for rotarycom screw air compressor in our company necessarily and the use of the mixture with other brand lubricant is at your own risk.
4. Please pardon us if some content in this manual is different with practical products due to structure and capability of the products is improved unceasingly after some period.

## **Safety warnings**

1. The air compressor shall be operated by special technologist. The operator shall read and understand the content in this manual carefully and abide by the working procedures and safety warnings in this manual.
2. When welding the pipes, you should move away the combustible material to a safety place to prevent fire risk. And also you should prevent weld sparks drop into air compressor or it will burn some components in air compressor.
3. The debug of new machine must be done by engineers in our company or recognized by our company.
4. Proper air switches, the corresponding blown fuse and other safety device shall be installed before the matched wire is connected to distribution board. In order to ensure the electrical equipment is safe and reliable proper ground wire must be connected, if necessary, the lightning protector shall be installed.
5. In order to prevent the machine head is jammed when reverses itself, people should test whether the turning of the compressor is correct the first time start the machine, change the power wire or motor.
6. The air compressor can't work at the exhaust pressure higher than that regulated on nameplate or the motor will be stopped due to overload or be burned.
7. The compressed air and electric source are highly dangerous which may result personal injury and death. So people should make sure the electric source has been cut off and all the compressed air in the air compressor has been released completely before do repair work or daily maintenance. Please don't face any exhaust vent of the air compressor system or air drive device to avoid being injured by the high-pressure gas. When cut off the electric source and do the maintenance, people should lock the electric switch box and hang up maintenance sign and "forbid to switch on" sign at the electric source place to prevent others switch on and supply electricity.
8. The repair work and maintenance can be done only when the air compressor stops run and cool completely or people will be burned.
9. Please don't start the machine enforcedly when there is trouble or unsafe factor. At this time people should cut off the electric source and make out an obvious mark then start the machine after the repair work being done.
10. When start the machine, operator shall be sure there is no person in the unit and then close the door. When test the machine during repairing progress, operator should be sure there is no person, tool, moving part or dangerous part contacts with it. Operator should inform surrounding people before starting the machine.
11. Forbid to use inflammable, explosive or volatilizable cleaning agent to clean the components of the air compressor. People should use safe cleaning agent without toxicity and corrosion.
12. The safety valve and protection system for stoppage must be checked regularly at least once every three months to ensure they are safe, sensitive and reliable.
13. The pressure vessel shall be monitored regularly. Please contact with local labor supervise department about this.
14. Proper fire extinguisher system shall be prepared near the unit.

# **Chapter I      Working Principle of Screw Type Air Compressor**

## **I. Introduction of Screw Air Compressor**

The screw air compressor made by our company is a new type and high efficient rotating compressor. It is made according to the principle that lubricant oil is infused into compression chamber and onto the bearing during the compression procedure by the power pump or the pressure balance produced by itself. It has the advantages of reliable running capability, few damageable parts, few components, small volume, small vibration, low noise and long service time, also it is easy to maintain and easy to realize automation.

Special oil spraying mode brings many advantages:

1. The lubricant oil is infused into compression chamber and onto the bearing by the pressure balance produced by system which simplifies lubricating system.
2. The lubricant oil forms a layer of elastic lubricant film between rotators and reduces the direct mechanical friction between the yin and yang rotors.
3. The lubricant oil sprayed can increase airtightness, reduce leak loss in the machine and improve the volume efficiency.
4. The lubricant oil can reduce the noise produced by high frequency compression.
5. The lubricant oil can absorb most of the compressed heat, so the single-stage compression ratio is as high as 16, while the exhaust temperature is still within the range required, also the rotors and case shell won't happen trouble due to the different thermal expansion coefficients.

## **II. Structure of Oil Spray Screw Air Compressor**

Double-screw air compressor is composed by one pair of Ying and Yang rotors with high precision tooth with each other, heavy load bearing with high precision and case shell. The Ying and Yang rotors tooth with each other and are installed parallelly in the case shell. The heavy load bearing realizes the orientation of axial direction and radial direction and also bears the axial thrust push from rotors. There are air inlet and outlet on the case shell and the air inlet lies on the top of the case shell and the air outlet lies on the bottom of the case shell. The precise cooperation between Ying and Yang rotors and among rotors and case shell of machine reduces the air leak and improves the efficiency. There is only the rotating motion of rotors and no reciprocating motion of components, which reduces the vibration of air compressor. The Ying and Yang rotors compress each other in the compression chamber and then improve the air pressure, at last, the compressed air is expelled out at the exhaust end. No synchromesh gears are set in the machine, while the pair of screws which just like one pair of gears do rotating motion through the driving screw drives the driven screw.

The drive between motor and air compressor is belt drive or elastic rotating joint drive.

## **III. Compressed Principle of Screw Air Compressor (refer to figures)**

### **1. Inspiration Process**

When rotors are rotating, space between gears will be formed due to one end of gear deviate from the tooth, then some vacuum will be formed in the machine, while at the same time space between gears puts through with the air inlet, and then the air will enter into the space between gears as a result of differential pressure. Along with the rotation of rotors, space between gears will be enlarged and the air enters into it will be improved. When space between gears is cut off with the air inlet, the space between gears is the largest and at the same time the air in space between gears will be closed. Then inspiration process is finished.

## **2. Compression Progress**

When the inspiration progress is finished, the air will be closed in the space between gears. Along with the rotation of rotors, the space between gears will be reduced gradually due to the tooth of Ying and Yang rotors, also the air in space between gears will also be reduced, then it will result the raise of the air pressure, thereby air compressed progress will be realized. When space between gears is put through with exhaust vent, space between gears is the least. Now, compression progress is finished.

## **3.Exhaust Progress**

Along with the decrease of space between gears, air with exhaust pressure will be delivered to exhaust vent continuously and then discharged, this progress will go on until the shaped conductor at the end tooth completely. At this time, the compressed air in space between gears is discharged completely through the exhaust vent and the enclosed space between gears becomes zero, then exhaust progress is finished.

# **Chapter II     Air Compressor Receiving and Installation**

## **1. Receiving**

Please check the quantity, mode, specification and attached information listed on packing list when receiving the air compressor.

Check whether the air compressor is damaged or has other quality problems.

If there is any default, damage or other quality problem, please record the detailed information and inform the business personnel of our company or the distributors to deal with it in good time.

## **2. Installation**

In order to make sure the air compressor to run normally and is convenient to be maintained and improve the air compressor efficiency and the quality of compressed air, please make a perfect plan before installation.

### **2.1 Installation Site**

The installation site of the air compressor shall be planned perfectly in order to maintain the air compressor expediently and avoid the air compressor running unsmoothly due to environment.

The air compressor shall be installed in room. The installation place shall be airy, has good lighting and is convenient to operate, repair and maintain. If the air compressor is installed outside, then the corresponding blind shall be established to prevent the decrease of the service life of the air compressor due to sunlight and rain.

The air compressor shall run at the ambient temperature lower than 40℃. The higher the ambient temperature is, the lower the efficiency and the exhaust quality of the air compressor are and the shorter the service life of lubricant is. In addition, the ambient temperature shall higher than 5℃ and shall higher than the solid point of water and lubricant.

The air compressor shall be installed at a good place with lower relative humidity, little dust, clean air and excellent ventilation.

If the factory has poor environment and much dust then a ventilating duct shall be installed which can induct clean air from a clean place. If necessary, a prepositive filter shall be installed to ensure the cleaning degree of the absorbed air and the service life of system components of the air compressor.



#### **Note**

**In order to reduce the flow resistance, the air inlet ventilating duct shall not longer than 4 meters.**

The necessary space to maintain the machine shall be prearranged around the machine unit. The distance between the round and the top of the air compressor unit and the wall is one meter at least.

Install hoisting device to maintain the machine expediently.

The compressor is a heat device, especially the air dive mode, so the ventilation heat release of the factory is very important. Installation of exhaust device according to the wind direction is necessary. The exhaust quality shall higher than the fan quality of circulating fan of air compressor or cooling fan, and the area of cooling air inlet shall be enough. A wind guide facility shall be installed at the air outlet of cooling fan of air compressor from which the heat air is discharged through air compressor and then keeps proper ambient temperature. The outlet of the cooling fan shall be kept away from the air inlet.

#### **Note**

**When the exhaust guidance is installed in unit, the outlet of the cooling fan of the air compressor shall be designed as a movable guidance to ensure there is enough space to install or dismantle the cooler and cover or other components.**

### **2.2 Base**

This type air compressor needs no special base. People just need to place the air compressor unit at a firm and flat ground and make the air compressor unit and the ground contact closely with each other. The additional vibration to the air compressor unit due to unevenness of the ground or incline of the air compressor unit shall be avoided.

In order to reduce the vibration produced by the run of the air compressor unit and prevent noise leaked from the gap between the air compressor unit and ground, it is recommended putting a rubber sheet with the thickness of 5~6mm and width of 80~100mm under the air compressor unit.

If the air compressor is installed upstairs then anti-vibration shall be done to prevent the vibration transmission or sympathetic vibration.

#### **Warnings**

**When installing the air compressor upstairs, people shall make sure the floor can undertake the corresponding vibration and weight.**

### **2.3 Matched Pipe**

The main pipe line shall have a inclination of  $1^{\circ}\sim 2^{\circ}$ , and be set the drainage valve at the lowest place to discharge the condensing sewage in the pipe line.

Proper pipe diameter shall be selected and the pressure fall of pipeline shall not exceed 5% of the rated exhaust pressure. In order to decrease pressure fall, it is better to select the diameter with value larger than designed value.

The branch pipeline shall be connected from the top of the main pipeline to avoid the condensed water flowing into the air device following pipeline.

When the diameters of the pipeline are different, then the reducing pipe shall be used to avoid the turbulence produced at the joints and resulting in large pressure loss and the shortage of the

service life of the pipeline due to the impulsion of air.

The buffer device such as air reservoir, drying equipment, cleaners and other equipments shall be prepared for the air compressor. The ideal configuration order is air compressor + sewage filter + air reservoir + prepositive filter + drying machine + postpositive filter (precision filter). The air reservoir can separate most of the sewage and the dirty oil. The air reservoir can amortize air, stabilize terminal air pressure and reduce the regulative times of air compressor. And also it can decrease air temperature and coagulate the water in air and lighten the load of postpositive filter and drying machine.

In order to prevent the pressure loss in the pipeline, the elbow, three-way valve and other valves in pipeline shall be cut down as soon as possible.

The ideal matched pipe is making the main pipeline encompassing the whole factory. Then any branch pipeline of the factory can gain outlets at two directions. Once the air used quantity in one branch pipe is improved, it will not result in obvious pressure fall in main pipeline.

The bypass pipeline and valves shall be installed at proper position at the drying machine, filters and other equipments need maintenance.

The flow speed in the delivery pipe of the compressed air with system pressure lower than 1.5Mpa must be slower than 15m/sec or it will result in too high pressure fall.

## **2.4 Cooling System**

The cooling water in water-cooling compressor must be soft water or the calcium, magnesium and other metallic ions will form water scale in the cooling water pipe and affect the cooling effect of cooling machine. If the circulative cooling water system is used then softener shall be added regularly to ensure the quality of cooling water.

### **Warnings**

#### **Water scale will affect the cooling effect seriously**

The automatic recharge system of cooling circulating system shall be perfect and reliable. Or else after run some time, the quantity of cooling water will be lack which will result in high temperature stop of the air compressor.

It is better to use the cooling water system in air compressor singly, and avoid common use to prevent the shortage of water which will result cooling effect.

The cooling tower in circulative water system shall satisfy the water quantity that the air compressor needs and the flow capacity and the delivery lift of the water pump also shall satisfy the request. The cooling tower shall be installed at the place where is convenient to disperse heat and ventilate air well.

The cooling pressure shall be controlled between 0.15~0.25Mpa normally and shall not higher than 0.5Mpas.

### **Warnings**

The pressure difference of the inlet and outlet of the cooling water shall be kept between 0.15~0.25Mpa. Too low pressure difference will decrease the cooling result.

The incoming flow temperature of the cooling water in air compressor shall be lower than 30°C and the water withdrawal temperature shall be lower than 40°C. Usually the temperature difference is 10°C.

The ventilation environment of the cooling air compressor shall be paid special attention to. In order to avoid high temperature and resulting in the stop of the air compressor, the air

compressor shall not be installed at the place near mechanism with high temperature or the site with bad ventilation. If the air compressor is installed at an enclosed site, then the independent air intake pipe and air outlet pipe equipment shall be installed additionally to facilitate the air circulation.

The heat exchanger of the air-cooling compressor shall be cleaned regularly to maintain the cooling effect of the cooling machine.

### **3. The Electric Safety Requirement**

Please select the power wire with proper diameter according to the power of the compressor and can't select the power wire with too small diameter or it may result in the burn of the lead due to high temperature and then result in danger.

It is better to use a independent set of electric power system to compressor, especially to avoid the parallel connection use with other different electric power equipment, or it may result in too large pressure fall, over load of the compressor due to imbalance of three-phase current or trouble in protection device, then affects the normal work of other electric equipment. The compressor with big power especially shall be paid attention to.

Configure proper air switches and fuse protectors according to the power of the compressor to ensure each component in the electric system is safe and reliable.

When distributing electricity to compressor, people should make sure that the supply voltage conforms to the rated voltage of the motor.

The ground wires of the motor or the system must be laid or it may leak current and result in danger. The ground wires can't be connect with the air delivery pipe or the cooling pipe directly.

The biggest working current of the motor can't exceed 3% of the rated current of the motor. If the three-phase current is not balance, then the balance between the lowest current and the highest current shall not exceed 5%. If the power voltage is not consistent with the rated voltage then the deviation between the two shall not bigger than 5%.

## **Chapter III   Technical Specification of Screw Compressor**

# RCB—Belt Drive Series

Mode		RCB-20A	RCB-25A	RCB-30A	RCB-40A	RCB-50A
Exhaust quality/ Exhaust pressure M <sup>3</sup> /min/Mpa (G)		2.5/0.7	3.2/0.7	3.8/0.7	5.0/0.7	6.7/0.7
		2.4/0.8	3.0/0.8	3.6/0.8	4.7/0.8	6.5/0.8
		1.9/1.0	2.4/1.0	3.2/1.0	4.3/1.0	5.7/1.0
		1.6/1.25	2.1/1.25	2.5/1.25	3.6/1.25	5.2/1.25
Exhaust temperature		Environment temperature +45℃				
Cooling mode		Air cooling				
Cooling fan	Mode	SK40	SK40	SK45	SK45	SK55
	Exhaust quality M <sup>3</sup> /min	77	77	96	96	164
	Power KW	0.35	0.35	0.55	0.55	1.0
Lubricant capability L		15	15	16	16	32
Oil content in air		≤3ppm				
Noise		63	63	65	68	72
Setting pressure of safety valve		Exhaust pressure +0.15MPa				
Drive mode		Belt drive				
Motor	Power KW	15	18.5	22	30	37
	Rotate speed rpm	1450	1450	1450	1450	1450
	Voltage / frequency	380V / 50Hz				
	Start mode	Y-Δstart				
	Isolation class	Class F				
Overall dimension	Length (mm)	1120	1120	1230	1230	1450
	Width (mm)	810	810	950	950	1030
	Height (mm)	1260	1260	1410	1410	1520
Weight (g)		630	680	780	850	1030
Notes		<ol style="list-style-type: none"> <li>1. The compressed air supplied by the compressor can only be used in industry, it can't be breathed by human before being dealt with properly, or it will result in damage, disease or death of human.</li> <li>2. The performance parameters are tested according to ISO1217. The referring operating mode is that the absolute pressure of air inlet is 0.1MPa and the temperature of the incoming air is 20℃.</li> <li>3. The meaning of letters: RC—Shark, B—belt drive , D---direct A—air cooling, W—water cooling.</li> <li>4. Our company reserves the design change right to research and improve this product, specifications subject to change without prior notice.</li> </ol>				

Mode		RCB-60A	RCB-75A/W	RCB-75AD/W	RCB-100A/W	RCB-125A/W
Exhaust quality/ Exhaust pressure M <sup>3</sup> /min/Mpa (G)		7.5/0.7	9.2/0.7	10.5/0.7	14.1/0.7	16.5/0.7
		7.5/0.8	8.8/0.8	9.8/0.8	13.1/0.8	15.6/0.8
		6.7/1.0	8.2/1.0	8.8/1.0	11.8/1.0	14.0/1.0
		5.5/1.25	7.5/1.25	7.5/1.25	10.0/1.25	12.1/1.25
Exhaust temperature		Environment temperature +45℃				
Cooling mode		Air cooling				
Cooling fan	Mode	SK55	SK75	SK75	SK75	SK80
	Exhaust quality M <sup>3</sup> /min	164	303	303	303	392
	Power KW	1.0	2.2	2.2	2.2	3.0
Lubricant capability L		32	54	54	54	54
Oil content in air		≤3ppm				
Noise		75	78	68	72	75
Setting pressure of safety valve		Exhaust pressure +0.15MPa				
Drive mode		Belt				
Motor	Power KW	45	55	55	75	90
	Rotate speed rpm	1450	1450	1450	1450	1450
	Voltage / frequency	380V / 50Hz				
	Start mode	Y- Δstart				
	Isolation class	Class F				
Overall dimension	Length (mm)	1450	2000	2000	2000	2000
	Width (mm)	1030	1450	1450	1450	1450
	Height (mm)	1520	1600	1600	1600	1600
Weight (g)		1100	1450	1650	1850	2050
Notes		1. The compressed air supplied by the compressor can only be used in industry, it can't be breathed by human before being dealt with properly, or it will result in damage, disease or death of human. 2. The performance parameters are tested according to ISO1217. The referring operating mode is that the absolute pressure of air inlet is 0.1MPa and the temperature of the incoming air is 20℃. 3. The meaning of letters: RC—Shark, B—belt drive , D--direct A—air cooling, W—water cooling. 4. Our company reserves the design change right to research and improve this product, specifications subject to change without prior notice.				

### RCD-- Shaft Coupling Drive Series

Mode		RCD-30A	RCD-50A	RCD-75A/W	RCD-100A/W	RCD-125A/W	RCD-150A/W
Exhaust quality/ Exhaust pressure M <sup>3</sup> /min/Mpa (G)		3.4/0.8	6.4/0.7	10.5/0.7	14.0/0.7	16.5/0.7	21.3/0.7
		3.2/1.0	6.1/0.8	9.8/0.8	13.1/0.8	15.6/0.8	20.0/0.8
			5.8/1.0	8.6/1.0	11.8/1.0	14.1/1.0	17.8/1.0
				7.3/1.25	10.0/1.25	12.1/1.25	15.1/1.25
Exhaust temperature		Environment temperature +45℃					
Cooling mode		Air cooling					
Cooling fan	Mode	SK45	SK55	SK75	SK75	SK80	SK80
	Exhaust quality M <sup>3</sup> /min	96	164	303	303	392	392
	Power KW	0.45	1.0	2.2	2.2	3.0	3.0
Lubricant capability L		16	30	54	54	54	90
Oil content in air		≤3ppm					
Noise		70	75	73	75	78	75
Setting pressure of safety valve		Exhaust pressure +0.15MPa					
Drive mode		Shaft Coupling					
Motor	Power KW	22	37	55	75	90	100
	Rotate speed rpm	2950	2950	1450	2950	1450	1450
	Voltage / frequency	380V / 50Hz					
	Start mode	Y-Δstart					
	Isolation class	Class F					
Overall dimension	Length (mm)	1230	1400	2150	2150	2150	2800
	Width (mm)	950	1030	1350	1350	1350	1600
	Height (mm)	1410	1490	1680	1680	1680	2080
Weight (g)		600	850	1650	1850	2050	2200
Notes		<ol style="list-style-type: none"> <li>The compressed air supplied by the compressor can only be used in industry, it can't be breathed by human before being dealt with properly, or it will result in damage, disease or death of human.</li> <li>The performance parameters are tested according to ISO1217. The referring operating mode is that the absolute pressure of air inlet is 0.1MPa and the temperature of the incoming air is 20℃.</li> <li>The meaning of letters: RC—Shark, B—belt drive, D—direct, A—air cooling, W—water cooling.</li> <li>Our company reserves the design change right to research and improve this product, specifications subject to change without prior notice.</li> </ol>					

Mode		RCD-175A/W	RCD-200A/W	RCD-250A/W	RCD-300A/W	RCD-350A/W	RCD-400A/W
Exhaust quality/ Exhaust pressure M³/min/Mpa (G)		24.7/0.7	29.8/0.7	34.1/0.7	40.3/0.7	44.2/0.7	55.0/0.7
		23.2/0.8	28.2/0.8	32.3/0.8	38.2/0.8	40.3/0.8	52.3/0.8
		20.7/1.0	25.2/1.0	29.1/1.0	34.4/1.0	37.7/1.0	47.1/1.0
		17.7/1.25	21.7/1.25	25.2/1.25	29.9/1.25	32.6/1.25	40.7/1.25
Exhaust temperature		Environment temperature +45℃					
Cooling mode		Air cooling					
Cooling fan	Mode	SK90	SK90	SK90	SK45	SK45	SK45
	Exhaust quality M³/min	554	554	554	96	96	96
	Power KW	4.0	4.0	4.0	0.45	0.45	0.45
Lubricant capability L		90	90	110	110	150	150
Oil content in air		≤3ppm					
Noise		75	78	78	75	75	75
Setting pressure of safety valve		Exhaust pressure +0.15MPa					
Drive mode		Shaft Coupling					
Motor	Power KW	132	160	185	220	250	315
	Rotate speed rpm	1450	1450	1450	1450	1450	1450
	Voltage / frequency	380V / 50Hz					
	Start mode	Y- Δstart			Resistance start-up		
	Isolation class	Class F					
Overall dimension	Length (mm)	2800	2800	2800	3080	3080	3080
	Width (mm)	1600	1600	1600	2100	2100	2100
	Height (mm)	2082	2080	2080	2400	2400	2400
Weight (g)		2400	3000	3500	4200	5000	6000
Notes		1. The compressed air supplied by the compressor can only be used in industry, it can't be breathed by human before being dealt with properly, or it will result in damage, disease or death of human. 2. The performance parameters are tested according to ISO1217. The referring operating mode is that the absolute pressure of air inlet is 0.1MPa and the temperature of the incoming air is 20℃. 3. The meanings of letters: RC—Shark , B—belt drive, D—direct ,A—air cooling, W—water cooling. 4. Our company reserves the design change right to research and improve this product, specifications subject to change without prior notice.					



## **Chapter IV System Flow Chart and System Function**

### **1. Intake and Exhaust System**

The intake and exhaust system is composed by the air intake filter cleaner, intake valve, compressor, oil barrel, the minimal pressure valve, rear cooler, discharge valve and connecting pipeline.

Air first enters into the air intake filter cleaner to filter the dust, and then passes through the air intake valve and enters into the compressor to be compressed, and mixes with lubricant oil completely. The mixture of oil and air which have been compressed enters into the oil barrel through the exhaust pipeline, and then forms oil drops through mechanic shock, change of flow direction and reduce of flow speed and the oil drops will fall onto the bottom of the oil barrel due to their own weight. Most of the lubricant oil will be separated from the mixture of oil and air and the remainder small quantity of the lubricant oil can be separated by the oil separator again. The lubricant oil being separated can be used repeatedly. The compressed air that has passed through the oil separator flows through the minimum pressure valve and enters into the air supply system.

#### **1.1 Air Intake and Exhaust**

##### **Function instruction of each compartments in intake and exhaust system**

##### **1.2.1 Intake Filter Cleaner**

- a) The intake filter cleaner is a dry paper filter and the hole size of the filter paper is about 10U. The intake filter can absorb the dust in the air and ensure the air that enters into the air compressor is clean, and also it can eliminate noise.
- b) The filter core shall be taken out to be removed away the dust every 500 hours. The cleaning method is blowing the dust by the low voltage compressed air from inside to outside, and the distance between the blow vent and the inside surface of the filter core is about 10mm. After clean work is done, please knock the filter core lightly to confirm the dust has been removed. If the filter core is too dirty then it shall be changed.
- c) There is one maintenance indicator or one pressure difference switch. When the pressure difference is increased to the setting value then the pressure difference switch (maintenance indicator) begin to activate and the block indicator of the intake filter cleaner shines which means the filter cleaner shall be cleaned or changed, but the compressor still can run.
- d) The service life of the filter core is 1000 hours usually. While if the compressor works at the environment polluted seriously, then the changed period of the filter core shall be shorter.

##### **1.2.2 Intake Valve**

- a) Content Control (the machine types lower than G-060)

It adopts ROT-COM special intake controller, and is composed by one basic adjustor and one control unit with flange (it can control all of the states), which ensures the screw compressor to run safely and economically. It has the following functions:

- 1) When the machine is started, the controller will close the intake valve to reduce start load.
- 2) When the machine is stopped or unloaded, the controller can release the pressure in the oil barrel to prevent the lubricant oil return to the intake filter when the machine is stopped.
- 3) The diversion design reduces intake noise greatly.

When the compressor is stopped, the intake valve will be closed as a result of the predetermined pressure of the spring, so when the compressor is started, the start load is the lowest. When the intake valve is closed, the bypass valve will guide the servo air flow to enter into the compressor which can prevent the vacuum is produced.

The power controller (EMC-2) activates automatically through the pressure switch. When the pressure is the highest, the magnet valve will open and control the unload of pressure above the piston in the air cylinder, then the intake valve will be closed due to the effect of the spring force, and then the compressor is at unload state. The magic valve closes when the compressor is started or controlled by the switch, which can control the rise of the pressure above the piston in the air cylinder, and the pressure can open the intake valve by overcoming the spring force, then the compressor is at load state.

When the air compressor is at the state of no-load, the pressure in oil barrel can be unloaded to 0.25~0.30Mpa. The compressor runs without load at the low back pressure, which reduces energy consumption.

b) Infinitely Capacity Control (the machine modes higher than G-075A)

It adopts the butterfly type intake control valve of Hoerbiger which has hammer clack valve.

When the compressor is started, the butterfly valve with an anti-vacuum hole which ensures the start of the compressor has no load is closed. When the compressor runs with heavy load, the three-way magic valve will open, and the high pressure air will affect the servo air cylinder, drive the butterfly valve to rotate and open the intake valve to realize the run with heavy load.

When the system pressure is improved to the setting pressure of inverse proportioning valve due to the reduce of the air quantity used, the proportioning valve will act and reduce the pressure of the air pressure. The valve handle of the servo air cylinder is shorted by the effect of the spring force and the butterfly valve rotates, which reduce the intake passage area and decrease the air intake quantity. When the air intake quantity is decreased to the air quantity used, the butterfly valve will at a balance place. This is the content adjust progress.

If the air quantity used is decreased very fast, the increased speed of the pressure exceeds the reaction speed that capability adjusts and the pressure reaches the upper limit of the pressure switch, the pressure switch activates, the three-way magic valve closes, the servo air cylinder returns to original state and the butterfly valve closes. At the same time, the relief magic valve opens, the air in oil barrel is discharged through relief magic valve, the pressure falls to empty pressure and the compressor is at the run state with minimal load. When the system pressure decreases to the lower limit of the pressure switch, the pressure switch activates, the three-way valve opens, the relief magic valve closes and the machine returns to run with heavy load.

### **1.2.3 Temperature Sensor**

All the conditions that the lubricant quantity is short, the cooling water quantity is short, the environment temperature is too high, the exhaust temperature is too high and the oil filter is blocked may result in too high temperature of the exhaust. When the exhaust temperature rises to the sensor setting temperature of 110°C, the temperature sensor will activate and the urgent stop may happen.

### **1.2.4 Oil Barrel**

The internal structure of the oil barrel makes the mixture of oil and air enter into oil barrel and forms oil drops through mechanic shock, change of flow direction and reduce of flow speed. The oil drops will fall onto the bottom of the oil barrel due to their own weight. Most of the lubricant

oil separated from the mixture of air and oil can be used as mechanic separating oil.

The oil barrel, the oil storage tank of the compressor, can store lubricant oil. For the machine modes lower than G060, the machine bodies are installed on the oil barrel directly. While for the machine modes of G075A and G100A, the machine bodies are installed on a fixed bracket.

The oil fine separator cores of the machines with modes higher than G150 are installed in the oil barrel.

One view oil mirror is installed on the oil barrel and also one oil relief valve is installed at the lowest place of the oil barrel. People should turn on the oil relief valve slightly before start the machine in order to remove the condensed water in the oil barrel. There is an oil port on the oil barrel.

Since the oil barrel itself can store some compressed air, so to some extent it can reduce the pressure wave in system pipeline and stabilize the pipeline system force. Due to the wide section area of the oil barrel, the compressed air can decrease the flow speed and the oil drops are separated. This is the first stage to remove oil.

### **1.2.5 Safety Valve**

The safety valve is installed on the oil barrel. When system happens trouble (the pressure switch is out of operation), the safety valve will open automatically, remove the high-pressure air in the oil barrel quickly and make the pressure decreases to the pressure lower than the rated exhaust pressure then ensure the safe of the machine unit and each of the system.

#### **Warnings**

**The safety valve has been adjusted well before leaving factory, so please don't adjust it freely.**

### **1.2.6 The Minimum Pressure Valve**

The minimum pressure valves of the machines with modes higher then G-060 are installed in the oil separating base plates which are connected with rotation oil separator by the corresponding screw threads.

The minimum pressure valves of the machines with modes higher than G-075 are independent types.

The minimum pressure valve is installed at the outlet of the oil fine separator and the start pressure is set between 0.4~0.5Mpa. The functions of the minimum pressure valve are as followings:

- a) Prior to establish the pressure that the circulation of the lubricant needs before it starts, ensures the lubricant to run normally in the oil pipeline, ensures the compressor is lubricated and reduces oil consumption.
- b) It will start only when the system pressure is higher than the setting pressure of the minimum pressure valve, can reduce the flow speed of the air flows through the oil fine separator, improves the separating effect and can prevent the oil fine separator is damaged by the big pressure difference of the former and the latter.
- c) When the compressor is used through Internet, the minimum pressure valve can act as a clack valve and prevent the compressed air in the system to return to the oil barrel and the machine body.

### **1.2.7 The Rear Cooler**

- a) To the air-cooling unit, the air drove by cooling fan flows through the cooler and exchanges heat with the compressed air, and then carries away the heat produced in the

compression process. The air-cooling unit is sensitive to environment temperature, so when selecting place to install the compressor, people shall pay attention to the ventilation condition and it is better to equip proper ventilation equipment to prevent the environment temperature of the machine unit is too high.

#### **Warnings**

**The dust on the surface of the cooler fin can affect the heat exchange effect greatly, so the cooler shall be cleaned regularly.**

- b) The water-cooling unit shall use the shell-and-tube cooler and cool the compressed air by the cooling water. The cooling water follows along the inside of the pipe while the compressed air follows along the outside of the pipe. The water-cooling cooler shall ensure the flow capacity of the cooling water. When the temperature of the incoming water is too high, the flow capacity of the cooling water will be improved. The water-cooling unit is not sensitive to environmental temperature and is easy to control the exhaust temperature.

#### **Warnings**

**Because the hard water will result in scale formation and affect the cooling effect, the cooling water shall be soft water. The cooling water with low PH value (water is acid) will corrupt the cooling pipe and result in trouble, so the cooling pipe shall be made by special cooper material.**

#### **1.2.8 The Relief Valve**

The relief valve is two-way normal open magic valve, when the machine stops or is empty it will open to drive out the compressed air in oil barrel, decrease the pressure in barrel to the lowest safe running pressure (to zero when the machine stops) and make the compressor start or run without load.

#### **2. Lubricant Circuit System**

The lubricant circuit system is composed by compressor, oil barrel, temperature control valve, oil fine separator, oil cooler and connecting pipe.

#### **2.1 The Lubricant Flow Chart**

For the spraying oil lubricant compressor, the pressure in oil barrel is higher than that on the spraying oil vent of the machine head, so the lubricant will flow through the temperature control valve, oil cooler (when the oil temperature is too low, it won't flow through the oil cooler) and oil filter in turn under the pressure. The lubricant oil is divided into two ways, one of them flows to the main oil nozzle, sprays into the compression chamber and mixes with the compressed air then lubricate and cool the machine. The other one enters the front and rear coupling bearings and gears, after lubricates them, enters into the compression chamber and mixes with air. The mixture of oil and air is discharged through the exhaust vent.

The mixture of oil and air enters into the oil barrel, and is separated out most of the oil by mechanical separation method, then is separated out the other remainder oil by oil fine separator (this part of oil returns to machine head through the second return to oil pipe). The clean compressed air flows through the minimum pressure valve and enters into the rear cooler to be cooled, then can be delivered to the use system.

#### **2.2 Lubricant Functions and Spray Oil Quantity Control**

Main functions of the lubricant oil sprayed into compressor

- a) Cooling function: the lubricant oil sprayed in vaporousness state mixes with the air and

absorbs vast of the compression heat produced in the compression progress, then decreases the exhaust temperature greatly.

- b) Lubrication: the lubricant forms a layer of elastic film which prevents the direct contact with the Ying and Yang rotors and then reduces the wear on the rotor surface. In addition, the lubricant flows to each oil site following the oil paths and lubricates each bearing and gear.
- c) Seal: the lubricant with some viscosity can fill up the gap between the Ying and Yang rotors and the gap among rotors and shell, decreases the area of the leak passage among rotors and shell, reduces the air leak loss in machine greatly and improves the volume efficiency of the compressor.
- d) Reduce noise: the oil is viscous liquid, can absorb and damp the sound energy and sound wave and reduce the high frequency noise and mechanicalness noise of the airflow in compressor.

## **2.3 Instruction of the Components in Lubricant Oil System**

### **2.3.1 Temperature Valve**

The oil cooler is installed a temperature valve which can keep the exhaust temperature above the dew point. The setting temperature of the temperature valve is between  $72 \sim 83^{\circ}\text{C}$ . The temperature valve begin to open when the temperature reaches  $72^{\circ}\text{C}$  and open completely when the temperature reaches  $83^{\circ}\text{C}$ .

The lubricant flows in from the inlet of the temperature valve. If the oil temperature is lower than  $72^{\circ}\text{C}$ , the temperature sensor will open the by-pass port and close the outlet, then the lubricant flows out from the bypass inlet without passing through the oil cooler, if the oil temperature is higher than  $72^{\circ}\text{C}$  but lower than  $83^{\circ}\text{C}$ , the temperature sensor will close part of the bypass port and open part of the outlet, then the lubricant flows out through the oil cooler mixes with the lubricant flows out from the bypass port. If the oil temperature is higher than  $83^{\circ}\text{C}$ , the temperature sensor will close the bypass port and open the outlet, then lubricant flows out from the outlet and cooled by the oil cooler.

### **2.3.2 Oil Cooler**

The cooling methods of oil cooler and the air rear cooler are different. There are two cooling methods of air cooling and water cooling.

- a) The air cooler connects together with the rear cooler which has the same structure with it.
- b) The water cooling unit adopts tube-and-shell cooler and cools the lubricant by cooling water. The cooling water flows along the inner of the pipe while the lubricant flows along the outside of the pipe. The water cooling shall ensure the flow quantity of the cooling water. If the temperature of the incoming water rises then the cooling water quantity will increase accordingly. When blocked, the tube-and-shell cooler shall be dunked in special liquid medicine and be cleaned the scale in pipe by mechanical method. Please make sure the scale has been cleaned completely.

### **2.3.3 Oil Filter**

The oil filter, a paper filter, can remove the impurities such as metal particles, bad things in oil and others to ensure the clean lubricant can flow into the working chamber of the main machine and to each oil site. If the lubricant contains dust and other impurities, then it will result in abnormal wear on the rotor profile, the mating surface of the gears and bearing and reduce the service life of the compressor.

The oil filter is installed one pressure difference switch. When the oil pressure difference increases

to the setting valve, then the pressure difference begin to activate, and the block indicator light shines which shows the oil filter shall be changed, but the compressor still can run. If the new machine has run 5000 hours, then the oil filter shall be changed.

Oil and oil filter shall be changed according to the pressure difference indicator light. If the pressure difference of the oil filter is very high, while the oil filter isn't changed, then it may induce shortage of incoming oil and then result in high temperature exhaust trip which will affect the service life of the bearing.

### **2.3.4 Oil Fine Separator**

The core of the oil fine separator is made by precision glass fiber. The vaporousness oil in the separated compressed air can be filtered out completely by the oil fine separator which makes the oil content in the compressed air is lower than 3ppm. The service life of the oil fine separator is 3000~4000 hours at normal. If the lubricant quality and the round environment are polluted seriously, then a preposition air filter shall be installed before air intake.

- a) The oil fine separators of the machines with modes lower than G100 are whole rotary system which are installed at the corresponding base plates.
- b) The oil fine separator cores of the machines with types higher than G150 are installed in the oil barrel.

The lubricant shall be selected according to the brand recommended by our company and the fake oil or the reproduced oil is forbidden to use.

Judgment terms of the ineffective oil fine separators:

- a) The oil in the compressed air pipe is increased abnormally.
- b) The pressure switch of the oil fine separator activates due to the increase of pressure difference and the block indicator light of the oil fine separator shines.
- c) The exhaust temperature increases.
- d) Whether the running current of the air compressor is too high.

## **3. Cooling System**

### **3.1 Air Cooling Unit**

Cooling system of air-cooling unit is composed of oil cooler, after cooler and cooling fan. Oil cooler and after cooler integrate together with consistent structures. Cold air is blew to the cooler by the cooling fan, passes the cooler fin, and exchanges heat with high-temperature compressed air and lubricating oil to realize cooling effect. The maximum allowable temperature of the air cooling unit is 40°C. When the ambient temperature is above 40°C, exhaust temperature will rise, which may cause high temperature stop.

### **Warning**

**The dust accumulation on the surface of Cooler fin has great influence upon the heat exchange. The cooler should be cleaned regularly to ensure safety. Please make sure the power is cut off before cleaning the cooler.**

### **3.2 Water Cooling Unit**

After cooler and oil cooler are usually two different shell-and-tube coolers with cooling water to cool down compressed air and lubricant oil. Cooling water is in the tube, and compressed air or lubricant oil is outside the tube. Inlet temperature of cooling water is designed to 30°C, therefore special attention should be given in the design of cooling water circulating system. The quality of

cooling water should meet normal industrial water regulations. Avoid the ground water directly. If the water quality is poor, it is necessary to take corresponding measures to improve the water quality, and make the water meet requirements of standards. Water-cooling cooler should guarantee the flow of cooling water. If inlet temperature of water rises, the flow of cooling water should be increased accordingly.

#### **Note**

**When the cooler is frost cracking in winter, cooling water should be exhausted completely after stop. If the unit is not used for a long time, cooling water should also be exhausted completely.**

#### 4. Cooling Water System

Cooling water system is composed of water-cooling oil cooler, after cooler, cooling tower, pump and connecting line.

##### 4.1 Cooling Tower

Cooling tower is to cool the cooling water to a proper temperature. This device is provided by the user himself.

##### 4.2 Pump

The Pump is to ensure the pressure and volume of cooling water.

##### 4.3 Quality of Cooling Water

To ensure the cooler has a good effect of heat exchange for a long term and lengthen its service life, the cooling water should be soft water. Detailed requirements are as follows:

- a) Cooling water should be close to neutral, namely PH is 6.5-8.5.
- b) Organic substances and floating impurities should be less than 25 mg/l, and oil content should be less than 5mg/l.
- c) Temporary hardness  $\leq 10^0$  (hardness  $1^0$  means 1 L water contains 10mgCaO or 7.19mgMgO).

##### 4.4 Inlet Water Temperature

- a) Inlet temperature of cooling water should be  $\leq 32^{\circ}\text{C}$ ; if it is higher than  $35^{\circ}\text{C}$ , oil cooler and after cooler cannot be in series and should set their independent inlet pipe and drain pipe.
- b) Inlet pressure should be 0.2Mpa or higher, and less than 0.5 Mpa.

#### **5. Electrical Protection System and Warning Device**

##### 5.1 Overload Protection for Master Motor

If the current of master motor exceeds the upper limit set by the protection device (heat breaker) in a certain period, activate the protection device, cut off the main power supply, and shut down the compressor urgently.

Reasons for motor overload:

- a) Compressor system failure: failures, such as oil fine separator block, automatic adjustment system failure, high-pressure protection malfunction and safety valve failure, cause the power consumption increases greatly and the current rises accordingly.

- b) Adjust the exhaust pressure up without authorization, which causes the power consumption increases greatly and the current rises accordingly.
- c) The internal motor is damaged, and the output is not enough.
- d) The supply voltage is so low that the current rises; 3-phase of the power supply is not balanced, the motor runs with phase opening, or the current of certain phase is too high.

### Note

**You should manually push the reset button to reset manually after the protection device (thermorelay) is activated. Otherwise, the compressor cannot restart.**

### Tip

**If the master motor stops urgently in operation due to overload, please contact the company's service department immediately. The company's technicians will assist you to inspect and confirm the failure reasons.**

#### 5.2 Overload Protection for Cooling fan motor

If the current of cooling fan motor exceeds the upper limit set by the protection device (heat breaker) in a certain period, activate the protection device, cut off the main power supply, and shut down the compressor urgently.

- a) The internal motor is damaged, and the output is not enough.
- b) The supply voltage is so low that the current rises; 3-phase of the power supply is not balance, the motor runs with phase opening, or the current of certain phase is too high.

### Note

**You should manually push the reset button to reset manually after the protection device (thermorelay) is activated. Otherwise, the compressor cannot restart.**

#### 5.3 Reverse Phase Protection Device of Motor

When the phase sequence of three-phase power supply input is different from the factory setting of the compressor, the motor cannot start, displaying phase sequence failure. In this case, what you should do is just to shift any two power wires.

### Warning

**Despite reverse phase protection device of motor, it is necessary to inspect whether the motor rotation is proper every time you change the wire or start the compressor.**

#### 5.4. Over-temperature Protection of Exhaust Temperature

Head exhaust vent is equipped with temperature sensor. When the exhaust temperature exceeds the rated value, activate the master control, and stop the compressor urgently due to over temperature. The rated value of exhaust temperature is usually set to 110°C.

Reasons for over-temperature of compressor exhaust:

- a) Temperature valve fails.



- b) The cooling effect of oil cooler reduces.
- c) Cooling fan fails.
- d) Ambient temperature is too high.
- e) Oil filter blocks.

## **5.5 Alarm Device**

### **5.5.1 Microcomputer-type Unit**

The system has several kinds of alarm devices. The following alarms are given by corresponding differential pressure switches.

- a) Air cleaner blocks.
- b) Oil filter blocks.
- c) Oil fine separator blocks.

Corresponding LEDs are displayed on the instrument panel. When certain filter blocks, its differential pressure switch activates, and corresponding LED lights, displaying the filter has been blocked. But the compressor does not stop, the alarm signal remains until the failure is disposed and reset is done.

Other alarm devices:

- a) Lubricant oil Pre-alarm Indicator

When it is time to use the lubricant oil, prompt the operator “it is time to use the lubricant oil”.

- b) Lubricant Grease Pre-alarm Indicator

When it is time to use the lubricant grease, prompt the operator “it is time to use the lubricant grease”.

- c) Motor Protection

Display short-circuit, rotation-clogging, overload, open-phase and current imbalance of the air end and fan.

- d) Anti-reverse protection for Air Compressor

When the phase sequence of three-phase power supply input is different from the factory setting of the compressor, the motor cannot start, displaying phase sequence failure. In this case, what you should do is just to shift any two power wires.

- e) Over-pressure Protection for Power Supply

When exhaust pressure is greater than the upper limit set, the controller sends an alarm and stops, showing the exhaust pressure is high.

- f) Failure Protection for Sensor

When presser sensor or temperature sensor is failed or disconnected, the controller stops to alarm, and prompts the sensor is failed.

- g) Protection for Body of Compressor

When the oil temperature exceed the set value 110°C, the controller automatically stops and sends an alarm, to prevent the body rotor from blocking or burnout.

### **5.5.2 Machinery-version Module**

Alarm devices:

- a) Protection for Motor

When three-phase current is imbalanced or overloaded, heat breaker automatically jumps and cuts off to realize urgent stop.

b) Anti-reverse Protection for Air Compressor

When the phase sequence of three-phase power supply input is different from the factory setting of the compressor, the motor cannot start, showing phase sequence failure. In this case, what you should do is just to shift any two power wires.

c) Protection for Body of Compressor

When the oil temperature exceeds the set value 110°C, the controller automatically stops and sends an alarm, to prevent the body rotor from blocking or burnout.

## **6 Control System and Electrical System**

- a) Monitor the operating state of the unit, and forecast the possible failures according to the state parameters.
- b) Adjust the exhaust volume of the compressor according to the variation of electric system to make both matching with each other.
- c) When the unit is not running normally, send an alarm or make an urgent stop timely.

### **6.1.1 Motor Start (Pressure reduction or Y start)**

In this period, air intake valve is closed, the three-way magnet valve is closed due to power off, the drain magnet valve is open due power off. The compressor intake side is in relative vacuum, and the lubricant oils sprays into the head under the differential pressure between the oil gas barrel and compression chamber. The compressor starts without any load.

### **6.1.2. Motor Runs under Full Voltage**

After the compress runs under full voltage, the three-way magnet valve is open due to power on, the intake valve is open gradually, the drain magnet valve is close due to power on, and the compressor begins to load, the pressure in the oil gas barrel rises gradually. When the pressure rises to the rated pressure of the minimum pressure valve, the smallest pressure value will be open, and the compressed oil is lead out to the system.

### **6.1.3 Load/Download**

If the gas consumption volume of the system is lower than the exhaust volume of the compressor, the system pressure will rise. When the pressure rises to the upper limit of the pressure switch, the three-way magnet valve is close due to power off, the intake valve, the drain magnet valve is open due to power off, and the compressor is in the process of downloading (empty load), and the system pressure falls.

When the pressure falls to the lower limit, the three-way magnet valve is open due to power on, the intake inlet open, the drain magnate is close due to power on, and the compressor is in the process of uploading (heavy loaded).

### **6.1.4 OFF**

Press the OFF button, the compress enters normal stop process. The three-way magnet valve and drain valve is power off at the same time, the intake valve is closed, and the compressed gas is exhausted from the gas oil barrel. Then, the motor stops running. Finally, press the URGENT STOP button to cut off the control power supply of all control circuits in the control box.

### **6.1.5 Urgent Stop**

When the exhaust temperature exceeds the rated value, exhaust pressure rises to the rated value of

pressure switch or the motor overload protection device is activated, the compressor enters the process of urgent stop. The motor is powered off immediately, meanwhile the three-way magnet valve and drain valve are powered off, intake valve is closed, and compressed air in the oil gas barrel is exhausted.

There is an URGENT STOP button. Push this button, and the compressor enters the process of urgent stop.

#### **6.1.6 Stop Automatically when not available for a long time.**

When the gas consumption of the system reduces, the compressor enters the process of gas volume adjustment in empty (no-load) operation state. If the empty operation time exceeds the rated time (preset as 20 min), then the compressor will stop automatically. When the system pressure falls to the lower limit of the pressure switch, the gas consumption of the system increases and the down time exceeds the set value, then the compress will start automatically and enters the process of uploading (heavy load). To ensure the motor runs normally, do not start the compressor frequently, and follow the principles of usually starting the compress twice at most per hour.

### **6.2. Electrical Principle**

Electrical principle is star-delta start.

Electrical principle of microcomputer automatic control refers to *Electrical Schematic Diagram Of Microcomputer Control Of Shark Screw Air Compressor*.

Electrical principle of instrument control refers to *Electrical Schematic Diagram Of Instrument Control Of Shark Screw Air Compressor*.

### **6.3. Controller**

Computer automatic control and instrument control are available.

The controller is to display the operating state of the compressor in operation. Daily care and maintenance of the compressor can be done according to the timer on the control panel.

#### **6.3.1 Instrument Control**

There are two control switches: ON button (green) and OFF (red) button.

There are also exhaust pressure gauge, lubricant oil pressure gauge, ampere gauge, time counter, LEDs for loading, overload and over-temperature.

Adjustment of empty- and heavy-load time:

- a) Open the door of electric box, find the breaker of such two times. Attention should be given to differentiate the breaker of empty-/heavy-load time from the breaker of Y - $\Delta$  start time.
- b) The breaker of Y - $\Delta$  start time has been adjusted when ex-factory. Do not adjust it without authorization.
- c) If the breaker of empty-/heavy-load time is set to 0, the compressor will automatically stops when the exhaust pressure is to the upper limit of the pressure switch, and the compressor will automatically restart when the exhaust pressure is to the lower limit of the pressure switch.

#### **6.3.2. Microcomputer Automatic Controller**

Microcomputer automatic controller can display the pressure, temperature, runtime and other operating states of the unit in operation, realizes such control functions as compressor start, Y - $\Delta$  conversion in operation, empty/heavy load, stop(standby)/startup (restart), has breakdown

stop/alarm protection functions such as due to overpressure, over-temperature, overload and block of three filters, and has record functions of operating parameters and failures.

### **A. Control Procedure**

#### **1) Press ON button to start (Y -△ start)**

The controller implements self check within 3 seconds after power on, and the compressor cannot start by pressing the ON button. After completion of self-test, the air end starts by pressing the ON button. The starting process of the air end: KM3 powered on, KM2 powered on → Y-type start mode → delay to (Y -△conversion time), KM3 powered off (KM1 and KM3 lock each other), KM1 powered on → motor △-type operation, and the start is over. In process of start, all magnet valves are powered off all the time, realizing empty-load start.

#### **2) Automatic Operating Control**

After the motor activates △ state, delay for a certain period, relief magnet valve and pressure switch are powered on, the empty compressor starts loading, and the pressure of oil gal barrel rises. When the pressure rises to the upper limit set (when unloading pressure), relief magnet valve and pressure are powered off, the compressor runs in empty-load state. If the pressure falls to the lower limit set (loading pressure value) in the specific period (in the empty-load time), relief magnet valve and pressure switch are powered on again, the compressor compresses the air normally to improve the pressure of oil gas barrel. If the pressure does not fall to the lower limit set (loading pressure value) in the specific period (in the empty-load time), the controller will automatically stop the motor to realize automatic stop of compressor due to long time unavailability. Only when the pressure falls to the lower limit, the motor starts according to the start procedure, and circulates like this.

#### **3) Manually load/unload in automatically state**

Under automatic state, the device is unloading state, press M to load. If the pressure is higher than the unloading pressure, charge magnet valve returns to unloading state after touching; If the pressure is lower than the unloading pressure, charge magnet is powered on and returns to the unloading state again until the supply gas pressure is higher than the unloading pressure. When the device is in loading state, press M to unload; If the pressure is higher than the loading pressure, charge magnet is powered off and returns to the loading state again until the supply gas pressure is lower than the loading pressure; if the pressure is lower than the loading pressure, unload is not available.

#### **4) Normal Stop**

Press the OFF button, relief magnet valve and pressure switch are powered off. After a certain period is delayed, the motor contact chip is powered off, the air end and fan motor stop running. The compressor can be started only by pressing the ON button.

#### **5) Anti Frequent Start Control**

Press the OFF to stop. When the compressor is not available for a long term, disorderly stop may cause the motor cannot start when the motor stops, and a certain period of delay is required. The controller in various stop states displays residue delay time in the time window (such as 90 seconds), and the motor can be started only when the residue delay time is 0.

### **B. Network Control**

- 1) When the controller network communication is set to Computer, computer network control can be realized.
- 2) When the controller network communication is set to linking, the network control

between controllers can be realized only with the 1# motor as the master motor.

### **C. Fan Temperature Control**

When the exhaust temperature is higher than fan startup temperature, the fan motor runs; When the exhaust temperature is lower than fan stop temperature, the fan motor stops running;

### **D. Disorderly Stop and Urgent Stop**

When the controller should stop the motor immediately due to such failures as electrical failure or exhaust temperature failure caused when the motor runs, the motor can be restarted only after such failures are removed. In case of emergency, press the URGENT STOP button and cut off the power supply of the controller and contactor.

### 6.3.3 Inlet Line Distribution

**Table of Power Line Configuration of Screw Air Compressor**

Power (HP)	Voltage (V)	Current (A)	Sectional Area (m <sup>2</sup> )	NFB (a)
10	220	26	8	40
	380	15.6	5.5	30
	440	13	5.5	20
15	220	37.6	22	60
	380	22	8	50
	440	19	8	40
20	220	48	30	100
	380	27.5	14	75
	440	24	8	50
25	220	60	38	125
	380	34.5	22	75
	440	30	14	60
30	220	74	50	150
	380	44	22	75
	440	37	22	75
40	220	93	80	100
	380	54	38	125
	440	46.5	30	100
50	220	115	100	225
	380	69	50	150
	440	57.5	38	125
60	220	135	150	300
	380	78	60	175
	440	71	50	150
75	220	172	200	400
	380	100	80	200
	440	85	60	200
100	220	229	250	500
	380	133	125	225
	440	120	100	225
125	220	286	150x2	600
	380	166	150	350
	440	146	150	300
150	220	350	150x2	600
	380	196	200	400
	440	170	200	350

## Chapter V Operation Instruction

### **I. Test: Power on and Power off**

1. Check the unit, check whether the air intake and outlet pipes, cooling water pipe, etc.
2. Check whether there is any maintenance tool or any other sundries.
3. Connect the power wire and ground wire. Test whether the voltage of main power supply is proper and the three phases are balanced.

### **Note**

**Before power supply is connected to the control cabinet, it is necessary to install proper air switch and blown fuse. It is necessary to connect the ground reliably.**

4. Check whether the oil level of the oil gas barrel is in the middle of view oil mirror.
5. If you check the unit long after ex-factory, you should add about 0.5 KL lubricant oil into the intake valve, and manually rotate the compressor several cycles, to prevent the head from burn down when starting.

### **Note**

**Do not fall any sundries into the body of the compressor, to avoid damage to the body of compressor.**

6. For the water cooling compressor, get through the water intake and outlet pipes.
7. Open the air intake valve.
8. Compressor rotation check.

Press the ON button, immediately press the Urgent Stop button, confirm the rotation of the compressor. Right rotation refers to the arrow on the body. If the rotation is wrong, what you should do is just to shift any two phase wires among the three phase wires from the master contactors in the control cabinet. Meanwhile, check whether the rotation of cooling fan or exhaust fan is right.

9. Start

Press the ON button, and the compressor will start automatically.

10. Check whether the instrument and LEDs are normal.

Gradually close the air outlet stop valve, and check whether the volume regulated pressure is consistent with the set value. If it is not consistent, please reset it. Check whether systems are normal. If there is abnormal sound, vibration, or oil or gas leakage, immediately press the Urgent Stop button to stop and check.

11. Within 10-15 seconds after the OFF button is pressed, the delay-on relay activates, the motor stops, so as to avoid oil spray caused by direct stop of the compressor under heavy load state.

12. Stop

Press the OFF button, the relief valve will discharge all compressed air in the release system, and the compressor will enter normal stop process.

### **II. Daily Checks Before Start**

1. Water drain of oil gas barrel: open the manual outlet valve of oil gas barrel and water separator to discharge polluted water accumulated in the process of stop, and close the outlet valve of oil gas barrel when lubricant oil comes out. If this work is neglected, the service time of lubricant oil will shorten, which will cause the burn down of bearing or block of the body.

### **Warning**

**Before opening the water drain valve or oil filling cap of oil gas barrel, please ensure there is**

**no pressure in the oil gas barrel. Otherwise, it may cause damage to persons.**

## **2. System Check**

Check the oil level, power supply, cooling water tower, air outlet stop valve, dryers, etc. (check the oil level within 10 minutes after stop).

## **III. Notes In the Operation of Compressor**

1. If there is abnormal sound or vibration, stop the compressor urgently.
2. When there is pressure in the container or pipe in operation, it is forbidden to release or block the pipe under pressure, and do not open unnecessary valves.
3. Check the oil level in operation and make sure the oil level is in a proper level. If the oil level is lower than the maximum level, stop the compressor. Add lubricant oil until there is no pressure in the oil gas barrel.
4. The condensed water in the oil gas barrel should be discharged every day, and the condensed water in the water separator should be discharged regularly. Or, install automatic blow down valve to discharge the pollutant automatically.
5. Check the parameters recorded by the instrument every per 2 hours in the operation, such as voltage, current, exhaust pressure, exhaust temperature and lubricant oil level.

## **IV. Disposal Measures for Long-time Unavailability**

Before starting the compressor after a long-time unavailability, you should deal with as follows, especially for high-humidity season or areas.

1. Stop for over one month.
  - ① Electrical equipment such as control panel should be packed with plastic film or oilpaper, to avoid invasion of humidity.
  - ② For the water cooling compressor, discharge the cooling water in the oil cooler and after cooler completely.
  - ③ If there is any failure, you should first maintain the compressor for future use.
2. Stop for over two months

Besides above measures, you should deal with as follows:

- ① Seal all openings to avoid invasion of humidity and dust.
  - ② Add lubricant oil before stop, and run for 30 minutes under heavy load, and discharge the condensed water in the oil gas barrel and oil cooler completely next day.
3. Restart Procedure
  - ① Remove protective film or oil paper.
  - ② Measure the ground insulation of the compressor, and the insulation should be above 1MΩ.
  - ③ Restart the compressor according to the test procedure of new compressor.

# **Chapter VI Daily Maintenance and Care**

## **I. Lubricant Oil Use Instruction**

### **1. Lubricant Oil**

Lubricant oil determines the functions and service life of micro oil screw compressor. If it is not used properly or the lubricant oil brand or type is not wrong, it will cause serious damage to the body of the compressor. The company's lubricant oil features inoxidizability, demulsibility, corrosion resistance and high flash point. The company's special lubricant oil for Shark Screw Air



Compressor should be used.

### **Warning**

**For any damage caused by lubricant oil not from our company or non-original parts or greatly shortening service of the compressor therein, the company will not undertake any responsibility.**

2. Factors that influences the effect of the lubricant oil
  - ① Poor ventilation, too high ambient temperature.
  - ② Too high ambient temperature or in rainy season.
  - ③ Environmental pollution is serious, with a lot of dust and powder.
  - ④ Exhaust temperature is too low or high for a long term.
3. Oil Change Procedures
  - ① Run the compressor under empty load to raise the oil temperature, convenient for discharge. Then press the OFF button to stop running.
  - ② When the relief oil valve is opened under pressure, the relief speed is fast but the oil can be sprayed out easily. Therefore, open the valve gradually to avoid scald due to spray splash.
  - ③ When the lubricant oil is discharged completely, close the relief valve and open the oil-filling cap to fill new oil.

### **Note**

It is necessary to discharge lubricant oil completely, such as in the pipe, cooler and oil barrel.

4. Note In the Use of Lubricant Oil
  - ① The utility time of lubricant oil cannot exceed the service life of this product. Otherwise, the quality of lubricant oil will decline, which will cause the high-temperature stop or carbon accumulation. Meanwhile, the burning point of the lubricant oil will fall, which will cause serious accident of compressor burn down due to spontaneous combustion of the lubricant oil
  - ② Implement systematic cleaning of lubricant oil way after 2 years from first use. Detailed operation: after replacing with new lubricant oil, run the compressor for 6-8 hours under heavy load, and change the lubricant oil immediately, which enable the pollutant residue in the system to be cleaned completely. Replacing the lubricant oil again will lengthen the service time relatively.

## **II. Instruction for Adjustment Operation**

### **1、Belt Adjustment**

For the belt drive unit, check the belt tension after operation for 30 hours in the first operation. If it is found that the tension is not enough, the belt should be adjusted. After this, adjust once per 1,500 hours.

- ① When adjusting the belt tension, adjust the motor base by adjusting the screw to make the belt under a proper tension;
- ② When adjusting or replacing the belt, do not spray the lubricant oil onto the belt or the belt pulley wheel, to avoid belt slip;
- ③ If the belt should be changed, it is necessary to change all belts together instead of one belt. Otherwise, the tension will be unbalanced.
- ④ After completion of adjustment, the motor pulley and the main wheel should be on the same surface, otherwise

## 2. Pressure Switch Adjustment

- ① There are two adjusting screws. One is pressure-adjusting screw. To increase the set value, adjust the screw clockwise.
  - ② The other is differential pressure adjusting screen. To increase the set differential pressure counterclockwise. If the operating pressure is 0.8 Mpa(G) and the differential pressure is 0.2 Mpa, the pressure of heavy- and empty-load is 0.8 Mpa(G) and 0.6 Mpa(G) independently.
  - ③ The pressure switch has been set before ex-factory. Do not adjust it without authorization. The differential pressure can be set according to the actual use.
3. Volume Adjustment (When HOERBIGER gas intake valve is used, the company's 75HP includes above use)

Volume adjustment system is used to adjust the exhaust volume to match with the system gas consumption, so as to run in the most energy saving and economical mode.

If the pressure switch is set 8bar unloading and 6 bar loading, then capacity adjustment of inverse proportion valve should be set 7.8 bar, namely when the pressure is 7.8 bar, the compressor starts volume adjustment, adjustment the opening ratio of the gas intake valve to reduce gas intake, to realize volume adjustment.

Counterclockwise rotate the volume adjustment valve to reduce the power pressure, or clockwise to increase the pressure.

## III. Parts Care

### 1) Air Cleaner(also called as Air Grid)

After the compressor is used for a certain period, the surface of air cleaner will be covered by the dust so that the air flow resistance increases. Usually, remove the air cleaner and clean the dust on the surface of the filter element every 500 hours of operation or when the corresponding differential pressure switch LED lights.

Cleaning method: flow the low-pressure condensed air to the outside from the inside. The outlet is 100 mm away from internal surface of the filter element. Blow the air from up to down in a circle orbit.

If the filter element is too dirty, the filter element should be changed. Usually, change the filter element every 10,000 hours, and shorten the cycle accordingly when the environment is relatively poor.

### 2) Oil Filter (also called as Oil Grid)

After the new compressor runs for 500 hours, change the oil filter. After this, change it every 10,000 hours. If the environment is relatively poor, shorten the cycle. When the differential pressure lights, it displays the filter is blocked, you should change it immediately. To remove it, use chain wrench or cloth band wrench.

### 3) Oil Fine Separator (also called as Oil fine)

The change cycle of oil fine separator is 3,000 hours, and the specific determines the actual situation. To remove it, use chain wrench or cloth band wrench. When the differential pressure lights, it displays the filter is blocked, you should change it immediately.

### 4) Lubricant Oil

When the new compressor runs for 500 hours, change the lubricant oil. After this, when the exhaust temperature is 75-95℃, change it every about 20,000 hours. If the environment is very poor or the exhaust temperature is relatively high or low for a long term, shorten the change cycle.

#### 5) Servo Cylinder (HOERBIGER gas intake valve) Care

When the gas intake valve operates dully, the servo cylinder should be maintained. Maintenance procedure:

- a. Remove the servo cylinder from the gas intake valve;
- b. Remove the bottom screw, and remove the rubber film;
- c. Clean the body of cylinder, spring and piston rod, and change the rubber film;
- d. Reassemble the cylinder. Before reassembly, add a little lubricant oil on the piston rod and rubber film;

#### IV. Daily Maintenance

1) Check before every start every day (refer to above)

2) Run for 500 hours

- ① Change oil filter for the first time after the new compressor runs;
- ② Clean air filter element and put the filter screen in front. Blow the condensed air from inside to outside under low pressure completely.
- ③ Change the lubricant oil.

3) Run for 1,000 hours

- ① Check the gas intake valve sensitivity, drag bar and other operating parts, and add the lubricant grease.
- ② Clean the air cleaner;
- ③ Check the oil filter or change it.
- ④ Clean the air-cooling cooler.

4) Run for 2,000 hours or 6 months

- ① Check the connection of oil and gas pipes at all parts;
- ② Change the lubricant oil and clean oil stain in the system;
- ③ Check the oil view mirror, and remove and clean it if necessary.

5) Run for 30,000 hours or one year

- ① Clean the gas intake valve, change O ring, and add the lubricant grease;
- ② Check all magnet valves and relief valves, and change them if necessary;
- ③ Check the minimum pressure valve;
- ④ Check the oil fine separator;
- ⑤ Change the empty filter element and oil filter element.
- ⑥ Add the lubricant grease to the motor.
- ⑦ Check whether all starters and pressure switch are normal.
- ⑧ Clean the oil way systems such as coolers.

6) Every 20,000 hours or 4 years

- ① Change the bearing, oil seal and axle sleeve of the body, and adjust the spacing;
- ② Measure the insulation resistance of the motor, which should be above 1 MΩ.

## Chapter VII. Troubleshooting

### 1. Overview

There are various reasons for failures of the compressor. Therefore, before maintaining or changing any part, please make an all-round analysis about reasons for such various possible reasons. Do not remove at will.

### 2. Possible Phenomena and Solutions.

No.	Phenomena	Possible Reason	Solution
1	Unable to start (when the electrical failure LED lights)	1. Fuse burn down	1. Ask the electrical engineer to repair or change.
		2. Thermorelay overload protection	2. Ask the electrical engineer to repair.
		3. Wire connection loose or in bad contact.	3. Repair and fasten.
		4. Voltage too low	4. Ask the electrical engineer to repair
		5. Motor failure	5. Ask the electrical engineer to repair
		6. Compressor head failure	6. Operate the jigger manually, and it cannot rotate, please contact the company's service department.
		7. Phase sequence protection failure	7. Check the power wire and joint.
2	Operating current too high, and the compressor stops urgently	1. Voltage too low	1. Ask the electrical engineer to repair.
		2. Exhaust pressure too high	2. Check the pressure gage. If the pressure exceeds the rated pressure, adjust the pressure switch
		3. Connecting points on the circuit in bad connection	3. Repair
		4. Type of lubricant oil improper	4. Check the type of lubricant oil, and change the lubricant oil.
		5. Drive belt loose.	5. Check and adjust
		6. Oil fine separator blocked	6. Replace oil fine separator
		7. Compressor head failure	7. Operate the jigger manually, and it cannot rotate, please contact the company's service department.
3	Operating value lower than the normal value	1. Air consumption large (when exhaust pressure is to the rated value)	1. Check the gas consumption of the system, and add a compressor if necessary
		2. Gas intake cleaner blocked	2. Clean or change
		3. Gas intake valve operates abnormally	3. Remove and clean, and apply the lubricant oil

		4. Gas volume adjusting valve operates abnormally	4. Reset the adjustment
		5. Pressure set improperly.	5. Re-adjust the set pressure.
4	Exhaust temperature high, and the compressor stops urgently.	1. Lack of lubricant oil	1. Check the oil level. If the oil is adequate, please stop filling
		2. Lack of cooling water	2. Check the differential pressure between the water intake and outlet pipes
		3. Temperature of cooling water high	3. Check the water intake speed.
		4. Ambient temperature high	4. Check the air exhaust, and reduce the temperature
		5. Oil cooler blocked	5. Check the intake and outlet temperature of cooling water, and normal temperature difference is 5-8℃. If the difference is below 5℃, the oil cooler may be blocked. Remove it and clean with cleaning agent
		6. Type of lubricant oil improper	6. Check the type of lubricant oil, and change the lubricant oil.
		7. Temperature control valve failure	7. Check whether the lubricant oil passes through the oil cooler, and change the temperature control valve if not.
		8. Plate fin heat sink dirty	8. Clean under low temperature air
		9. Oil filter blocked	9. Change
		10. Cooling fan failure	10. Repair
		11. Temperature sensor failure	11. Change
5	Exhaust temperature lower than 70℃	1. Cooling water too much	1. Adjust the cooling water outlet valve to adjust the water level to a certain degree.
		2. Ambient temperature too low	2. Adjust the cooling water outlet valve to adjust the water level to a certain degree; and reduce the radiation area for air-cooling type.
		3. Empty load for a long term	3. Increase the air consumption.
		4. Exhaust temperature gauge displays improperly	4. Change the exhaust temperature gauge
		5. Temperature control valve failure	5. Change the temperature control valve

6	Exhaust pressure too high (oil gas barrel)	1. Relief component (such as relief valve and gas intake valve) operates abnormally	1. Check whether the relief component works normally
		2. Relief magnet valve failure	2. Change
		3. Minimum pressure valve failure	3. Repair and adjust the opening pressure
		4. Control gas leakage	4. Repair and fasten
		5. Control pipe filter blocked	5. Maintain the filter
7	Exhaust pressure lower than the rated pressure	1. Gas consumption of the system greater than exhaust volume	1. Reduce the gas consumption, check whether the gas pipe leaks, and add a compressor if necessary.
		2. Gas intake filter blocked	2. Clean or change
		3. Gas intake valve cannot be opened completely	3. Check the operation of gas intake valve and the settings of pressure switch
		4. Pressure sensor failure	4. Change
		5. Pressure switch failure	5. Change
8	System pressure higher than the rated pressure	1. Pressure sensor failure	1. Change
		2. Relief component (such as relief valve and gas intake valve) operates abnormally	2. Check whether the relief component works normally
		3. Relief magnet valve failure	3. Change
		4. Control gas leakage	4. Check and fasten
		5. Control pipe filter blocked	5. Maintain the filter
9	Oil content of exhaust gas too high, the cycle of filling the lubricant oil shortening, and the cleaner emits oil smoke when stop.	1. Lubricant oil level too high	1. Check the lubricant oil and discharge some properly
		2. Oil return pipe blocked	2. Remove and clean
		3. Exhaust pressure too low	3. Adjust the pressure switch to the set value.
		4. Oil fine separator broken or damaged	4. Change with a new one
		5. Maximum pressure valve spring damaged	5. Change with a new one
10	Unable to run under full load	1. Pressure switch failure	1. Change with a new one
		2. Three-way magnet valve failure	2. Change with a new one

		3. Gas intake valve runs abnormally	3. Remove and clean, then apply the lubricant grease, and check whether the control pipe is smooth
		4. Maximum pressure valve runs abnormally	4. Remove and check whether valve seat and check valve are damaged, and replace them if damaged
		5. Control pipe leakage	5. Check the leakage position and faster
		6. Controller failure	6. Repair or change
11	Unable to run under empty load, gauge pressure is still the operating pressure or rises when empty load, and the safety valve activates.	1. Pressure switch failure	1. Repair, and change if necessary
		2. Gas intake valve failure	2. Remove, clean and apply the lubricant grease
		3. Relief magnet valve failure or relief pipe blocked	3. Repair, and change if necessary
		4. Volume adjustment file damaged	4. Repair or change
12	Compressor exhaust volume lower than the normal value	1. Gas intake cleaner blocked	1. Clean or change
		2. Gas intake valve failure	2. Remove, clean, and apply the lubricant grease.
		3. Oil fine separator blocked	3. Change
		4. Relief magnet valve or pipe leakage	4. Repair, and change if necessary
13	Empty/Heavy load frequent	1. Pipe leakage	1. Check the leakage position and fasten
		2. Differential press of pressure switch too small	2. Reset
		3. Gas consumption unstable	3. Increase the capacity of the gas tank
14	The gas intake cleaner emits oil smoke when stop	1. Gas inlet valve loose or blocked	1. Repair, and change if necessary
		2. Urgent stop	2. Check whether the gas intake is blocked, and remove, clean and apply the lubricant grease if locked
		3. Minimum pressure valve leakage	3. Repair, and change if necessary
		4. Relief valve does not discharge	4. Repair, and change if necessary
		5. Electric circuit mistake	5. Ask the electric personnel to repair or change.

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Name	Lubricant oil	Oil Filter Element	Oil Fine Separator	Air Filter Element	O Ring	Rotor bearing	Motor	Air Intake Control Valve	Cooler	Pipe	Safety Valve	Belt	Fan Bearing	Temperature Sensor	Pressure Gauge
Time															
500h	○	○	△	△					△		✓	✓		✓	✓
2000h	○	○	○	○			☆		△		✓	✓		✓	✓
3500h	○	○	○	○			✓	✓	△	△	✓	✓		✓	✓
5000h	○	○	○	○			☆	✓	△		✓	✓	△	✓	✓
6500h	○	○	○	○			✓	✓	△		✓	✓		✓	✓
8000h	○	○	○	○	○		☆	✓	△	△	✓	✓	△	✓	✓
9500h	○	○	○	○			✓	✓	△	△	✓	✓		✓	✓
11000h	○	○	○	○			☆	✓	△		✓	✓	△	✓	✓
21000h	○	○	○	○	○		✓	✓	△		✓	✓		✓	✓
30000h	○	○	○	○	○	○	☆	✓	△		✓	✓		✓	✓

Note:

○ is to change

✓ is to check

△ is to clean

☆ is to apply the lubricant grease

The above maintenance items are only for reference. Maintenance cycles of new products definitely determine upon the operating environment of the compressor. Therefore, poor environment may cause the cycle of consumption products shortening.



# Operation Record of Screw Air Compressor

MMYY

Date										
Time										
Item										
1. Oil level of oil gas barrel										
2. Air cleaner △ P indicator										
3. Oil filter △ P indicator										
4. Oil fine separator △ P indicator										
5. Operating current (A)										
6. Operating voltage (V)										
7. Exhaust pressure (kg/cm <sup>2</sup> G)										
8. Exhaust temperature (°C)										
9. Lubricant oil (kg/cm <sup>2</sup> G)										
10. Operating hours (hour)										
Recorder										
Remark										

Note: ① For items 1-4, Mark ✓ when it is normal, and x when it is abnormal (try to remove the failure)  
 ② For Items 5-10, record with data.

**Shark has the right to change the design of the product, and has no responsibility to make corresponding revision or improvement. Product specifications or parts of certain types are subject to change with notice.**

